



# AFCTN Report 94-037

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## Air Force CALS Test Network



## Effectiveness Study

28 February 1994



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### **Effectiveness Study**

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# **Air Force CALS Test Network Effectiveness Study Report**

## **1. Introduction**

### **1.1. AFCTN Description**

The mission of the Air force Continuous Acquisition and Life-cycle Support (CALS) Test Network (AFCTN) is to evaluate the effectiveness of the CALS standards for technical data interchange and to demonstrate the technical capabilities and operational suitability of those standards. The AFCTN is also chartered to carry out tests and evaluate emerging technologies and products that support the CALS requirements.

The AFCTN continues to build upon a solid CALS technical base. The professional staff of the AFCTN has developed and maintains a high degree of expertise for supporting the CALS specifications and standards. The AFCTN maintains an array of test hardware and software tools that have been acquired, developed, and perfected over several years of use. These resources give the Test Network an unrivaled ability to provide CALS data testing services and related technical assistance, unavailable from any other source, to DoD programs and their contractors. The AFCTN has emerged as the preferred testing organization by both government programs and industry to test data for CALS compliance.

Using its test resources and technical proficiency, the Air Force CALS Test Network (AFCTN) provides assistance to CALS data developers and users. Industry and DoD programs send data to the Air Force CALS Test Bed (AFCTB) or the Lawrence Livermore National Laboratory (LLNL) facilities for testing to determine if it meets CALS requirements. The AFCTN staff compliments its testing service by providing technical assistance to data preparers. In addition, the AFCTN provides support to related Air Force project data and documentation activities, and to CALS related programs of the other services.

### **1.2 Purpose**

This Effectiveness Report presents and evaluates the activities and accomplishments of the AFCTN during the period of September 1993 through February 1994. For the most part qualitative measures of effectiveness are relied on to describe the AFCTN achievements. Quantitative statistics are provided where they are available.

### **1.3 Overview**

The primary task of the AFCTN is CALS data testing. Digital data files, submitted by DoD contractors and other sources, are tested with respect to five CALS standards and specifications. These activities are described in section two. Section three presents AFCTB and LLNL CALS product analysis efforts that closely parallel their data testing activities. The AFCTN continually

evaluates nearly three dozen commercial products as they are used in data testing. The AFCTB has information on many CALS related commercial products.

Four demonstration and prototype efforts are described and presented in section four. The Initial Graphic Exchange Specification (IGES) Transfer and Manufacturing Demonstration and the Electronic Contract Prototype development are highlighted. The report of this activity shows the resolve of the AFCTN to critically evaluate CALS standards and to apply CALS and CALS related technology to bring increased efficiencies of operation to Air Force organizations.

The capabilities and effectiveness of AFCTN tool and product developments are presented in section five. Seven tool developments are highlighted along with the creation of four test packet products. These accomplishments illustrate the ability of the AFCTN staff to provide effective test tools and products for their own use, and for DoD and industry CALS users.

Section six describes support activities of CALS and CALS related standards. A significant effort was completed which recommended direction for the support of the VHSIC Hardware Description Language. Interactive Electronic Technical Manual activities, support to the CALS/Concurrent Engineering Industrial Steering Group, Standards Division, Electronic Data Interchange related activities, and other standards support efforts are described.

Sections seven and eight summarize the interaction of the AFCTN with the CALS users and CALS related technical communities. Section seven lists more than 150 government, industry, and educational organizations which have interacted during the past six months with the AFCTN. Section eight describes the liaison, presentation, and conference activities that support the primary mission area by providing AFCTN information to CALS users and potential customers.

Sections nine and ten address AFCTN physical resources, the CALS Internet and bulletin board systems, and hardware and software upgrades that are necessary to accomplish the AFCTN mission and support the CALS Program. Section eleven describes management initiatives that have added to the AFCTN effectiveness.

## **2. Data Compliance Testing**

The primary task of the AFCTN is CALS data testing. DoD program offices and their contractors submit data on electronic media to the AFCTB or to LLNL to determine if it meets CALS data requirements. The AFCTB and LLNL technical staffs have developed unique test tools as required, but rely mostly on commercial off the shelf (COTS) software packages. AFCTN test procedures provide a cross-check between the tools that data submitters have used in preparing their data and a number of tools available to the AFCTN. The AFCTN tests IGES, raster, Standard Generalized Markup Language (SGML), and Computer Graphics Metafile (CGM) data for compliance with the CALS standards and specifications listed in table 2.1.

Std/Spec Number	Title
MIL-STD-1840	Automated Interchange of Technical Information
MIL-D-28000	Digital Representation for Communication of Product Data: IGES Application Subsets and IGES Application Protocols
MIL-M-28001	Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text
MIL-R-28002	Requirements for Raster Graphics Representation in Binary Format
MIL-D-28003	Digital Representation for Communication of Illustration Data: CGM Application Profile

**Table 1. CALS Standards and Specifications**

## 2.1 AFCTB Data Testing

The AFCTB conducted tests on 31 submissions received during the six month period, September 1993 to February 1994. Most of the data is received on the standard 9-track tape in the MIL-STD-1840A format; however, a trend is building for the data to be delivered in other media formats including computer diskettes and direct electronic transmission. The test data submissions contained some 713 data files. The number of data files submitted and tested are shown for each type of data in table 2.

CALS Data Specification/Standard	Number of Data Files Tested
MIL-STD-1840 (Media Spec)	51
MIL-D-28000 (IGES)	74
MIL-M-28001 SGML)	72
MIL-R-28002 (Raster)	425
MIL-D-28003 (CGM)	91

**Table 2. Data Compliance Test Statistics, September 1993 - February 1994**

Table 3 showing similar data for the preceding six month period is provided for comparison. It is noted that in the earlier period 59 file sets had been received and tested, while in the latest period 51 sets were submitted for testing. Several of the latter sets contained a large number of files making the number of data files tested in each period nearly the same.

CALS Data Specification/Standard	Number of Data Files Tested
MIL-STD-1840 (Media Spec)	59
MIL-D-28000 (IGES)	66
MIL-M-28001 SGML)	74
MIL-R-28002 (Raster)	548
MIL-D-28003 (CGM)	93

**Table 3. Data Compliance Test Statistics, March 1993 - August 1993**

### **2.1.1 MIL-STD-1840A/B Testing**

MIL-STD-1840, Automated Exchange of Technical Information, is the cornerstone requirement for CALS data. There are several points to be made about the general acceptability and the compliance rate with this key standard. The standard has been expanded to recognize and permit the use of media other than 9-track tape. This change and other changes introduced in MIL-STD-1840B were anticipated to enhance its acceptance and ease of application. However, a number of problems have been reported by those using this revision. AFCTB evaluations have confirmed several problem areas. These have been reported to the MIL-STD-1840 custodian. It is anticipated now that a further revision will be developed in the not too distant future. The AFCTB seeks to take an active part in this update of MIL-STD-1840.

### **2.1.2 Compliance with CALS Data Specifications**

It was noted that the number of data sets submitted for testing SGML, raster, and CGM decreased during the last six months. The number of IGES data sets increased 12%.

It was observed that much of the data tested was from first time submitters; there were fewer follow-up data submissions in the past six months. Preparers learn from the evaluations of their initial submissions and their subsequent submissions tend to be compliant. This is a measure of the effectiveness of the testing feedback that AFCTB customers receive.

## **2.2 LLNL Data Testing**

LLNL performed 4 informal tests of MIL-STD-1840A tapes and approximately 40 informal tests of MIL-R-28002A Type I files received as a result of acquisition program support. LLNL also performed 3 informal tests of MIL-R-28002A Type II files submitted by organizations trying to implement Type II capabilities, and 10 informal tests of MIL-D-28003A. In each case, variances from the standards were documented in letters to the submitter.

## **3. CALS Product Analysis**

The AFCTN relies heavily on commercial products in data testing and other activities. Many of these software tools are loaned to the AFCTN facilities by their industry developers. The experience gained in the use of commercial products at the AFCTB and LLNL test facilities are valuable in a number of aspects. The AFCTN technical personnel have gained first hand knowledge of data processing tool state-of-the-art, and an understanding of how CALS specifications are being interpreted by the various vendors while using the commercial tools.

The AFCTN does not make formal evaluations of the products used, but provides informal advice to vendors when products exhibits anomalies or characteristics that appear to be at variance with CALS specifications. Copies of the Quick Short Test Reports (QSTRs), reporting on data testing, are forwarded to the vendors of software used in AFCTN data tests. The reports provide feedback to the vendors on the performance of their products with respect to the specifications



feedback to the vendors on the performance of their products with respect to the specifications they support and also with respect to other commercial tools used in the same data tests. The AFCTB has access to over 40 commercial products used in data and other testing activities. LLNL has 23 products in use. Tables B-1 and B-2, located in appendix B, list these products, their vendors, and their applications.

AFCTN customers indicate that they invest considerable effort to identify suitable products to support their CALS capability developments. The AFCTN technical staff has much of the information that these individuals need. Individual AFCTN staff have been able to assist, in an informal manner, those who seek advice and assistance in their CALS capability developments.

#### **4. Prototyping and Demonstration Initiatives**

The AFCTN develops prototypes and conducts demonstrations to support CALS initiatives at both the AFCTB and at LLNL. As opportunities and needs occur, specific tasks are undertaken. Four activities, which have been conducted during the past six months, are described and evaluated in this section.

##### **4.1 IGES Transfer and Manufacturing Demonstration**

The AFCTB sponsored the IGES Transfer and Manufacturing Demonstration to test the capabilities of the CALS IGES standard, and to demonstrate that IGES data can be efficiently transferred to, and effectively used by, disparate computer-aided design (CAD)/computer-aided manufacturing (CAM) facilities to manufacture parts for weapon systems. The IGES Transfer and Manufacturing Demonstration was specifically designed to test the technical completeness and the operational suitability of the IGES specification, as it is supported and implemented by government and industry organizations. Typical reprocurment data for an F-5 aircraft nosewheel steering subassembly was selected and converted to raster and IGES data. Both IGES and raster file data were placed on the AFCTB UNIX server, accessible by Internet, and on the PC-based AFCTB dial-in bulletin board system (BBS). A total of 54 organizations volunteered to participate in the demonstration, including 17 US DoD organizations and 23 industry organizations, 6 Allied country government and industry organizations, and 8 educational institutions. Each participant was asked to manufacture one part. The results of the demonstration were presented at the 1993 CALS EXPO and AutoFact expositions.

Most of the participants who reported problems in receiving and loading the IGES files into their CAD systems were able to work around the problems. However, some used the backup raster files to generate CAD data to manufacture the parts. Completed parts were received from 50 of the 51 participating manufacturing organizations. The participants felt their involvement benefited them and was worth more than the investments they made in being part of the demonstration. Some indicated that the test had surfaced problems in their IGES CAD systems which they corrected. The involvement also created a better understanding of the need for strict CALS compliance. The demonstration highlighted the need for closer attention to standards to ensure data transfer and data translation problems are minimized. The demonstration clearly pointed out

that large IGES files, such as from a major CAD system, cannot be used by smaller systems. This pointed to a recommendation that, if acquired engineering data may be used at some future time in smaller CAD systems, the IGES file requirements should be appropriately defined.

## **4.2 SGML Demonstration**

A demonstration activity was initiated by the AFCTB to examine the ability to transfer SGML files among heterogeneous hardware and software systems. SGML test files were developed at the AFCTB and are being serially transferred among the participants, with each one adding to the text before passing the files to the next participant. Originally it was planned that as many as 50 organizations might participate. However, progress has been slow; only seven organizations have been involved to date.

The lack of progress in this demonstration is due, in the opinion of the AFCTB staff, to a general lack of SGML expertise, and the unavailability of equipment and software which supports the CALS SGML requirements. This is seen in both the government and industry. The AFCTB continues to pursue this SGML test and further determine the status of SGML expertise and resources in the technical data community. The final outcome of this technical evaluation and the development of necessary corrective initiatives is considered critical to the continued success of the CALS initiative.

## **4.3 Electronic Contract Prototype**

The AFCTB initiated a project to employ the synergistic application of CALS digital data transfer standards and advanced electronic data processing techniques for the management of contract documentation. An "electronic contract" prototype was developed by the AFCTB, using commercial software products, that demonstrated features that promise a breakthrough in transitioning from paper-based to digital-processed contracts. Representatives from Headquarters Air Force Materiel Command (AFMC), the Aeronautical Systems Center (ASC), and vendors of digital data processing products cooperated in the support of this effort.

The prototype demonstrated features that promise significant time savings, and thus cost savings, can be realized by implementing this technology. These features included capabilities for assisting the spectrum of contract management from development through maintenance and modification of contract documents. The electronic contract demonstrated the capability to share contract information among decentralized users for reference, review, comment, or coordination. The prototype also illustrated the ease and efficiency in accomplishing contract comment and coordination processes, dramatically improving the flow and sharing of information in these activities. The effort resulted in the endorsement of the effort by key AFMC contracting managers, and a potential supported follow-on effort to implement and install an enhanced demonstration prototype system within the AFMC contracting community.

#### **4.4 CALS-EDI Small Business RFQ Test/Demonstration**

LLNL completed a CALS-Electronic Data Interchange (EDI) small business test/demonstration with Sacramento Air Logistics Center (SM-ALC). The purpose was to demonstrate an electronic alternative to the current paper-based Request for Quotation (RFQ) process with technical data attachments (e.g., engineering drawings). Three RFQs, containing CALS technical data from the Engineering Data Computer Assisted Retrieval System (EDCARS), were sent via EDI to seven small businesses to see if they could receive the RFQs, and display the CALS engineering drawings with enough clarity to bid. The test was successful in showing that most of the data recipients could participate in an electronic procurement process using CALS, EDI, and the computer equipment they had on hand.

### **5. CALS Tool and Product Development**

#### **5.1 Tool Development**

Although the AFCTN has access to over 60 COTS tools, some of which were developed to specifically meet CALS standards and specifications, the AFCTN has nevertheless found the need to develop additional tools to effectively test CALS data and perform related tasks. Some of these are being used and have been widely accepted by the CALS community, meeting needs of CALS users. Other tools have been developed for the AFCTB and LLNL testing activities. Tool development and upgrade progress activity during the past six months is described in the following paragraphs.

##### **5.1.1 TAPETOOL**

The AFCTN CALS TAPETOOL, initially developed several years ago, has become an important capability needed by a large sector of commercial companies involved in developing and delivering CALS compliant data in support of MIL-STD-1840 requirements. Although there are commercial tools available to assist in 1840 data preparation, they lack the functionality of TAPETOOL. TAPETOOL uniquely parses 1840 header information and tape data, and documents header and data compliance with MIL-STD-1840 requirements. CALS community feedback indicates that it is impossible to insure data, being developed for delivery to DoD customers, complies with the MIL-STD-1840 requirements without using the AFCTN TAPETOOL product.

The AFCTB published and began distributing a comprehensive TAPETOOL Users Manual in September 1993. The manual provides detailed instructions for using the full compliment of capabilities available in TAPETOOL. The manual will make this AFCTB tool even more valuable and effective, especially in the hands of new users. The AFCTN maintains both UNIX, VMS, and PC-based versions of the tool which support MIL-STD-1840A. The MIL-STD-1840B version of TAPETOOL is available as a beta tool for evaluation.

Additional feedback from TAPETOOL users indicates that the tool should be enhanced to handle larger data requirements for commercial data production. An industry user also recommended that TAPETOOL be made available as Government Supplied Software (GSS) and specified in government contracts requiring delivery of MIL-STD-1840 data. The AFCTB is investigating TAPETOOL enhancements, including enlarging its file handling capability.

### **5.1.2 DTD Tag Validator**

The AFCTB developed the Document Type Definition (DTD) Tag Validator which provides the user with a capability to read a DTD and automatically compare it against the CALS MIL-M-28001 approved tag set. The tool provides two reports; an exception report, which identifies unapproved tags that appear in the DTD; and a report that lists the approved tags, that appear in the DTD, and their definitions. The tool runs on Microsoft DOS operating systems. It is available from the AFCTB dial-in BBS. This tool should be an effective aid in the validation of DTDs as they continue to be developed by various DoD organizations.

### **5.1.3 CALS Raster Tools**

#### **5.1.3.1 AFCTB Developed CALS Raster Viewer**

The first upgrade of the CALS Raster Viewer (Xrastb) was accomplished with the Version 1.1 release in December 1993. Several bug fixes and an improved conversion utility were integrated in the tool. The UNIX based tool is now available in compiled format for Intergraph, as well as Sun Sparc and Silicon Graphics hardware. Plans for a DOS version are being considered to give the tool a greater application base. A user's guide is being prepared. Xrastb was distributed to Warner Robins, Sacramento, and San Antonio Air Logistic Centers (ALCs) for their use. It was also made available to the Joint Computer-aided Acquisition and Logistic Support (JCALS) program for evaluation and potential integration in the JACALS Computer Assisted Data Acceptance (CADA) raster tool. All versions of the tools are available from the AFCTB UNIX file server via Internet. Xrastb is also available from the AFCTB on diskette media.

#### **5.1.3.2 LLNL Raster Tool Development**

LLNL ported existing AFCTB CALS raster tools from the Sun 3/280 platform to their SparcStation. LLNL also developed the following new CALS/raster tools:

Raster Decompression Tool. A visual debug tool that decompresses a CALS raster file and points out graphically, on a screen presentation, the exact location of compression/decompression errors.

PADWIDTH. A tool that expands a CALS raster image so the width is a multiple of 16 pixels.

CONVERT. A tool that converts the Hollerith information in the CALS raster header "scrdocid" field into the various formats required by the DoD repositories.

PAD. A tool that automates the evaluation of CALS data files and automatically adds zeroes to a file to make the total file size a multiple of 128 bytes.

Raster Header Editor. A CALS raster header editor developed to facilitate easy editing of headers.

## **5.2 Product Development**

The AFCTB and LLNL technical staffs completed development of four CALS test packets during the period of this report. These packets contain sample data files that meet the latest versions of the CALS specifications for text and graphics. Test packet products are developed to assist government and industry organizations to perform validation testing of their tools which they use to develop CALS compliant data. This assistance can to some extent reduce CALS user dependence upon the AFCTN for data testing. These products are available for down load from the AFCTB PC-based BBS and the UNIX-based file server, and also on diskette media. As soon as these products were placed on the AFCTN BBS they found immediate application with industries developing and supporting a number of DoD acquisition programs including the B-2, and JCALS programs. Four test packets developed by the AFCTB are further described:

MIL-D-28000A (IGES) Test Packet. A test packet consisting of 100 validated test files for testing IGES tools.

MIL-M-28001B (SGML) Test Packet. Test data files were prepared and tested for compliance with MIL-M-28001B. This test packet also includes sample IGES, Raster, and CGM files plus two generic Format Output Specification Instances (FOSIs) for MIL-M-38784B and MIL-M-38784D.

MIL-R-28002A (Raster) Test Packet. Eight type I raster files and four type II Raster files that meet the current MIL-R-28002A graphics requirements.

MIL-D-28003A (CGM) Test Packet. The AFCTB made four CGM files in MIL-D-28003 format and one file in MIL-D-28003A format in test packet format for use within the AFCTN.

LLNL test packet development involved two efforts:

MIL-R-28002A (Raster) Test Packet. A revised MIL-R-28002B Type I Test Packet with added software tools and updated text. The latest version is dated January 1994.

CALS-EDI Test Packet. A design and development of a CALS-EDI Test Packet in October 1993, that represents a significant effort to develop a test resource to meet a demand for future EDI testing.

## **6. CALS Standards Support**

The technical staffs at both the AFCTB and LLNL actively support the development of CALS and CALS related standardization efforts where their expertise can be effectively used. Also these personnel investigate other standardization initiatives to determine their relationship to CALS. The relationship of these standards to CALS and the benefit of these efforts to CALS are described below.

### **6.1 AFCTB Activity**

#### **6.1.1 VHDL**

The AFCTB completed the Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL) Standard Compliance Test Planning Study in December 1993. VHDL standardizes the design documentation of digital systems, subsystems and components. The study also investigated requirements to support VHDL standardization activities, in particular the development of a VHDL tool validation test suite.

VHDL was developed to support the DoD VHSIC technology requirements to model and document digital electronic systems. It is both a design tool and a documentation tool. VHDL is widely used across industry and has growing industry support. DoD and Federal guidance requires VHDL application. Although CALS Program guidance designates VHDL as a CALS "building block data format," and the Office of the Secretary of Defense (OSD) has designated the Air Force as the lead service for VHDL, the AFCTN has not, as yet, become involved in VHDL testing, or in VHDL technical support.

The study observed that while VHDL is widely used in industry and is supported by a number of tools and tool vendors, these tools are not uniformly compliant with the industry ANSI/IEEE 1076 VHDL Standard. Conforming VHDL tools are required to maximize both VHDL effectiveness during system design and development, and the assurance that VHDL models will be usable for future reprocurement and redesign. Inestimable cost savings will accrue in the future support of digital systems that have been designed and documented with VHDL, if standardization is maintained. There is a need for VHDL tool and model validation; however, the key to these is the development of a VHDL tool test suite.

The study recommended several steps leading to the planning and development of a VHDL validation capability in the AFCTB. The AFCTB study conclusions and recommendations are considered key to the immediate support of VHDL and, in turn, its most effective application in the support of DoD systems acquisition and support.

### **6.1.2 PDES/STEP**

The AFCTN plays a vital role in the activities of the IGES/Product Data Exchange using STEP (PDES) Organization (IPO). An AFCTB technical staff member continues to chair the IGES Acceptance Test & Methodology (IATM) committee. He led the effort to develop the IGES testing plan which was submitted for publication in November 1993, and continues to be involved in the development of test methodology planning for the Standard for the Exchange of Product Model Data (STEP).

### **6.1.3 BCL**

The Electronics Industries Association (EIA) standard, EIA RS-494B, 32 Bit Binary CL (BCL) and 7 bit ASCII CL Exchange Input for Numerically Controlled Machines, is being considered as a candidate CALS standard for manufacturing. The BCL neutral format is machine independent, i.e., any BCL controlled machine tool should be able to manufacture parts identical to those produced on other BCL controlled machine tools.

The AFCTB has completed an initial review of the standard. Preliminary review findings show that the use (and reuse) of digital data for the manufacturing process closely parallels the use (and reuse) of digital data for the design process. The AFCTB has initiated an in-house demonstration of BCL capabilities using a PNC-3000 table-top computer-aided modeling machine on loan to the AFCTB. BCL data files to test and demonstrate the BCL capabilities have been obtained from Ogden Air Logistics Center (OO-ALC). This AFCTN involvement will provide valuable feedback on the maturity of BCL for use throughout the DoD and industry.

The AFCTN also continues to support the Integrated Data Strategy (IDS) program Technology Advisory Group (TAG) with technical expertise in BCL as a foundation capability for standardizing the interchange of manufacturing data across the Air Force.

### **6.1.4 IETM**

The AFCTB began an Interactive Electronic Technical Manual (IETM), MIL-M-87268, specification and testing requirements study in order to develop and implement a strategy and capability for IETM technical and testing support. While the primary purpose of the current effort is targeted to establishing a specification testing capability, the expertise being built will support other IETM technical activities.

## **6.2 LLNL Activity**

### **6.2.1 Internet Binary Data Transfer Protocol --MIME**

LLNL successfully transferred CALS engineering and technical publication documents using the new Internet binary data transfer protocol, Multipurpose Internet Mail Extension (MIME). This Internet-based approach seems to avoid many of the pitfalls LLNL identified with the American National Standards Institute (ANSI) 841 transaction set.

### **6.2.2 CALS/CE ISG Standards Division Support**

LLNL participated in the quarterly meetings of the CALS/Concurrent Engineering (CE) Industry Steering Group (ISG) Standards Division, specifically in the Drawings and Graphics Committee (DAGC) and Business Case Committee. The goal of the Standards Division is to provide technical guidance on the direction and future development of the CALS standards. LLNL served as the DAGC leaders of the CGM and EDI task groups. LLNL submitted four Technical Activity Proposals (TCAPs) for specific additions or modifications to the CALS standards. Of the seven TCAPs approved by DAGC, three were submitted by LLNL.

### **6.2.3 ISO/IEC 8632, CGM Activities**

LLNL leads the ANSI X3H3 CGM standards committee in molding CGM requirements. The ANSI X3H3 committee is the US voice into the international CGM standardization effort. International Standards Organization/International Electronics Organization (ISO/IEC) 8632:1992/Amendment 1, which defines how to write a CGM applications profile, has completed ballot as a draft international standard. Upon its issuance, MIL-D-28003 will be rewritten to conform to the ISO/IEC format, and will be registered as an International Application Profile for CGM. LLNL restructured the table defining the application profile. LLNL also served as the international liaison on X3H3 committee activities.

In another activity, LLNL did a thorough review for the David Taylor Laboratory development of the Navy Guide for the use of CGM/MIL-D-28003, providing considerable guidance in updating the Navy draft. Once the draft is finalized, it, or some modification of it, may be suitable for adoption by the Air Force.

### **6.2.4 Electronic Data Interchange**

LLNL provides broad support to the development of standards associated with EDI. The AFCTN, through the LLNL, provided instrumental support in developing the DoD conventions for the ANSI X12 841 transaction set. LLNL identified five cases during the CALS-EDI Small Business RFQ test/demonstration performed with McClellan AFB. Subsequently, LLNL was invited to participate in ANSI X12 841 subcommittee meetings and the national ANSI X12 meeting in San Francisco.

LLNL developed a proposal to test Digital Equipment Corporation (DEC) X.435 product for interoperability with the CALS standards. (DEC is reportedly the first US firm to produce an X.435 product). X.435 was designed specifically to solve many of the problems that LLNL has encountered with the interaction of transaction sets 840 and 841 during their CALS-EDI test/demonstration. DEC has accepted the LLNL proposal, and initial test planning has begun.

As part of the AFCTN ANSI X12 support, LLNL participates on the subcommittee responsible for leading the X12 modification to merge X12 and the international EDI standard, United



Nations/EDI for Administration, Commerce and Transportation (UN/EDIFACT). This AFCTN participation helps to insure that the resulting standard will support CALS requirements.

## **7.0 Government, Industry, and Educational CALS Technical Support**

The purpose of this section is to document the breadth of the support that the AFCTN provides in terms of the organizations that are served. In the last six-month period, the AFCTN has supported or interacted with more than 150 government, industry, and educational organizations, AFCTN "customers," in their efforts to understand, develop, and use CALS data resources and data preparation capabilities. The support provided by the AFCTN is described throughout this report: data testing, providing unique CALS tools and products, and lending technical assistance in developing individual organization CALS capabilities.

The organizations that have been assisted by or interacted with the AFCTB operations in Dayton, Ohio, and the LLNL operations in Livermore, California for the period September 1993 to February 1994 are listed in the following paragraphs.

### **7.1 Acquisition Programs**

The following acquisition programs were supported by the AFCTN data testing and technical support activities. Assistance was provided directly to the program managers and also to their contractors. Through these contacts the AFCTN better understands the acquisition environment and its data management problems. As a result the AFCTN focuses its efforts to real solutions. Eighteen programs are listed, representing all three services.

<u>Program</u>	<u>Service</u>	<u>Program</u>	<u>Service</u>
ATOS (CALS core program)	Air Force	JSTARS	Air Force
EDCARS (CALS core program)	Air Force	MILSTAR	Air Force
IDS (CALS core program)	Air Force	JCALS (CALS core program)	Army
B-2	Air Force	TOW ITAS	Army
CSOC	Air Force	JEDMICS (CALS core program)	Navy
DMSP	Air Force	Defense Printing Service	Navy
F-15	Air Force	EMSP	Navy
F-16 IMIS	Air Force	JSOW	Navy
F-22	Air Force	NTSC	Navy
IMIS	Air Force	FCIM	DoD

### **7.2 Software Product Vendors**

The AFCTN uses the products of over 35 vendors in the performance of CALS data testing. The vendors involved and the tools that are currently in use are listed in Appendix B. There is the obvious benefit to the AFCTB and LLNL to be able to use these products in performing data evaluation. There is also a benefit to the vendors as their tools are closely examined by repeated applications. When problems are surfaced, the vendors are advised. Also copies of data test reports are sent to the vendors whose tools are involved in the testing.

### 7.3 DoD Laboratories and Depots

Twenty-seven organizations within a number of DoD logistics centers and depots, laboratories, and DoD contracted agencies were supported by AFCTN data testing services and activities. Sixteen participated in the AFCTB IGES Transfer and Manufacturing Demonstration. Nine requested and were provided AFCTN test tools and seven were provided other CALS related information.

4950th Test Wing/DMMF	Marine Logistics Spt Base, Barstow	Rock Island Army Arsenal
Anniston Army Depot	Naval Air Warfare Cntr, China Lake	Sandia National Laboratory
Army Research Laboratory	Naval Air Warfare Cntr, Indianapolis	SA-ALC/LDAF
Carderock Division, NSWC	Norfolk Naval Shipyard	SA-ALC/TI-1
CSRC, Orange, TX	NIST/CLS	SM-ALC/TILAA
CSRC, Scranton, PA	OC-ALC/PKDEE	Watervliet Army Arsenal
FAA/NAIIS Program Division	OC-ALC/TIETD	WR-ALC/TILAA
Letterkenny Army Depot	OC-ALC/TILDOS	WR-ALC/TIME
Marine Logistics Spt Base, Albany	OO-ALC/TIETA	WL/MNAV

### 7.4 Commercial Industry

Over the six month period the AFCTN has evaluated their data, assisted, or had contact with in a CALS related area the following 89 companies.

AAI Corporation	E.W. Meisengauch Group	PACO
Accurate Information	Ford Motor Company	Perot Systems
Advanced Tool Co.	Foreign Broadcast Inc	Radar Systems Group
Advent, Inc	Frontier Engineering	Riverside Machine Company
Alliant Techsystems	Frame Technology Corporation	Rocketdyne
Allied Signal	GM-NHO MTC	Rockwell International
Allied Signal Technical Services	GM/EDS	Rolls-Royce MEB
Alpha Mfg Development Center	IBM SID Boulder	Rosetta Technologies
Anderson Corporation	IGES Data Analysis	Saztec International
Applied Data Technology	Image Memory Systems	Serv-Air
Applix, Inc	Industrial Data Link	Sikorsky Aircraft
Aquidneck Data Co.	Intergraph Corporation	Smithfield Industries
ArborText, Inc.	International Technology	Smiths Industries
Auto-trol Technology	Kincaid Custom Machinery	Softquad
Autodesk, Inc	Knowledge Base International	Software Publishing
Ball Aerospace	Litton Data Systems	Southeastern Technologies
Boeing Defense & Space Group	Lockheed Missile & Space Systems.	Southwest Research Institute
Cadkey	Lockheed Missiles	Sunset Resources
Carberry Technology	Lockheed Saunders	Sunstrand Aerospace
CDI - Michigan	Loral Aeronutronic	SYSCON
Cimlinc	Loral Defense Systems	TAMSCO
Cleveland Advance Mfg Program	Loral Space and Range Systems	Texas Instruments
Computer Logics	Lotis Development Co.	Testron Defense Systems
Computing Devices Co.	Mantech International	Trico Industries
Concurrent Technologies	MCM Corporation of America	UNISYS Government Systems
Cubic Defense Systems	Moore Quality Tooling	U.S. Extrusions & Tools
Data Conversion Lab	Modern Engineering	Westinghouse Electric
Dyncorp	Northrop Corp.	Westinghouse, Inc
E-Systems	O'Neil & Associates	Wiz Worx
Enable Software Inc.	Oklahoma Aerospace Cont. Asst.	Wright Tool & Engineering
Evans Associates	Overland Data	Xerox Corp.

## 7.5 Schools and Universities

Eight of the educational institutions listed here were involved in the IGES Transfer and Manufacturing Demonstration. One institution requested AFCTN information. Other educational contacts have occurred with mutual benefit; however, they are not specifically documented.

Central State University  
Eastern Kentucky University  
Industrial Technology Institute

Machine Learning Center  
New Mexico State University  
Pennsylvania State University

Pioneer Area Vo-Tech School  
Robert E. Byrd Institute  
Tennessee Technological Univ.

## 7.6 International Organizations

Eight of the allied country government and industry organizations listed below were participants in the IGES Transfer and Manufacturing Demonstration. The AFCTB provided requested test tools, test data, and information to six organizations. One company participated in data testing.

Australian Dept of Defense  
British Aerospace PLC (UK)  
CAE Aviation Ltd. (Canada)  
Computing Devices Co. (Canada)  
Electronics Branch REME (UK)

Fraunhofer Institute (Germany)  
Giat Industries (France)  
Micro-Data Ltd. (Israel)  
Naval Eng Test Estab (Canada)  
Rolls Royce PLC (UK)

Royal Australian Navy  
Softquad (Canada)  
TRAUB (Germany)  
Vickers Shipbuilding (UK)

## 8.0 Liaison, Conferences, Presentations, and Publications

### 8.1 Liaison

The AFCTN carries on liaison support with several CALS related programs and provides support to a number of weapon system development programs involved in the acquisition of CALS data. Other activities support related professional organizations and conferences where the AFCTN provides information and personal interface with CALS users. These activities promote CALS program and effectively assist in developing the CALS technical community.

#### 8.1.1 AFCTB Liaison

CALS Shared Resource Center (CSRC), Orange, Texas. The AFCTB provided programmatic information on how to develop a CALS Government Concept of Operations (GCO) and CALS Implementation Plan (CALSIMP).

Customer Base Expansion. An AFCTB management and technical team has begun to explore avenues to expand the AFCTB customer base to organizations where funding for AFCTN work can be secured. A strategy and briefing has been developed to present AFCTN resources and capabilities. Initial contacts were made and briefings have been presented to the following organizations:

CASC Battlecreek

Marine Corps Quantico

Navy Jacksonville

MIL-HDBK-59B Revision. AFCTB technical staff submitted recommendations which were approved and included in the update of the DoD CALS Program Implementation Guide, MIL-HDBK-59B. Also an AFCTB technical staff member supported the handbook comment reconciliation meetings.

### **8.1.2 LLNL Liaison**

CALS Strategic Plan. LLNL staff participated in reviewing and providing comments to the DoD CALS Executive's CALS Strategic Plan as it was developed. The comments provided emphasis on testing and prototyping capabilities available through the AFCTN.

CSRC, Orange, Texas. LLNL provided information on CALS and EDI and a sample of the image data LLNL used in support of the AFCTN supported CALS-EDI Small Business RFQ Test/Demonstration.

Area Organization Liaison. LLNL staff have had opportunities to join in meetings, provide briefings, and discuss CALS related issues with a number of area organizations that have interest in CALS and CALS related technologies. Various common interests were highlighted, among them: LLNL CALS-EDI Small Business RFQ Test/Demonstration, LLNL Intelligent Archive Project, and the LLNL Electronic RFQ Implementation. The organizations are listed below.

- California Manufacturing Technology Center
- California State University
- Center for Applied Competitive Technologies in California
- Concurrent Engineering Implementation Study Group (CE-ISG)
- DOE Technologies Enabling Agile Manufacturing Project
- Smart Valley Consortium (Silicon Valley area initiative)
- CommerceNet (San Francisco Bay area initiative)
- InterLinear Technologies, Inc. (Pacific Rim initiative)

### **8.2 Conferences**

AFCTN representatives attend a number of conferences annually. Attendance, technical participation, and presenting demonstrations at major technical conferences, as noted in the following paragraphs, are considered a very effective way to expand the awareness of the CALS initiative and the support available from the AFCTN. Valuable feedback from CALS implementors and other users is obtained by the AFCTN attendees.

CALS Expo '93. Both AFCTN organizations participated in this conference. The AFCTB displayed and distributed information on its test and prototype demonstration activities in the AFCPO booth area. The AFCTB IGES Transfer and Manufacturing Demonstration drew much attention. These displays offered opportunities to present the capabilities of the AFCTN to the large number of people who attended this conference to learn specifically about CALS.

AutoFact. The IGES Demonstration was displayed at the AutoFact exposition and provided a focus for presenting AFCTN activities to AutoFact attendees. CALS standardization concepts and standards testing.

Alliance for Digital Information Applications. LLNL represented the AFCTN on the newly-formed Alliance for Digital Information Applications (ADIA). ADIA is the Pacific Rim focal point of Electronic Commerce (EC) technology, focusing on EDI and CALS initiatives. Its role is to coordinate and integrate the various resources available locally and nationally, including the National Information Infrastructure, government and institutional outreach, defense conversion, education, and the private sector.

Documation '94. The AFCTB participated in this internationally attended conference and exposition. Great interest in CALS testing was evidenced at the CALS Program booth. A large number of published QSTRs and AFCTN handbooks were distributed. Thirty-nine industries requested AFCTB documents to be sent to them after learning about specific AFCTB activities.

Interop. LLNL demonstrated CALS capabilities at two Interop conferences. The conferences attracted approximately 90,000 visitors and feature networking capabilities. Prior to LLNL involvement with the conference, there were no CALS applications in the demonstrations. LLNL found great interest among attendees in the Washington, DC area in the spring of 1993. In the summer conference in San Francisco, LLNL did a "Birds of a Feather" session that attracted a small, but very interested, group with urgent, focused needs. LLNL plans to continue this relationship with Interop as long as it remains fruitful.

### **8.3 Presentations and Training**

The AFCTB provided CALS presentations and Test Bed demonstrations for the following:

- AFIT System 370 Digital Data Management classes
- AFIT System 230 Technical Order Management classes
- Dayton Association for Computing Women meeting
- Norwegian Ministry of Defense

The LLNL provided CALS presentations for the following:

- DOE CAD/CAE Users Conference
- CMTC/CACT Conference
- Autodesk CAD Camp
- Interop '93
- Northern California CALS Interest Group
- CALS Expo
- Oklahoma Aerospace Contracting Assistance Center
- Canadian CALS Industry Steering Group
- San Antonio Air Logistics Center

## 8.4 CALS User Groups

The two AFCTN organizations, AFCTB and LLNL, participate with a number of local area interest groups that support the application of CALS standards and technology, and provide resources for some of the technical activities conducted by these groups. The technical interchange is mutually beneficial, and the feedback to AFCTN from the interest group members and their employer organizations is of great value to the AFCTN in focusing its test, demonstration and outreach activities. Representative involvement with four groups is described in the following paragraphs.

Indiana, Kentucky, and Ohio IGES Interest Group. The IKO Group continues to expand its membership. Quarterly meetings are being held at participating government and industry work locations to allow each of the membership to showcase his/her company's/organization's IGES capabilities. Noteworthy for this reporting period is the relationships being fostered between government and industry. The AFCTB continues to use this group as a means of providing the latest CALS capabilities and information to both government and commercial groups that are integrating CALS capabilities into their working environments.

Northern California CALS Interest Group (NCCIG). LLNL has continued its leadership role for the NCCIG, one of 15 active regional interest groups of the CALS/CE Industry Steering Group (ISG). Group membership consists of over 40 Northern California industry and government organizations including McClellan Air Force Base, Lockheed Missile and Space Company, Loral, Oracle, United Technologies, and Auto-trol. LLNL serves on the NCCIG executive committee. LLNL has invited the Bay Area SGML Users Group to attend the NCCIG meetings to expand CALS influence into this central California regional SGML users group

Northern California EDI Users Group (NCEUG). LLNL has joined the NCEUG in an effort to introduce CALS and, in particular, the AFCTN CALS-EDI capabilities and testing support experiences and capabilities. LLNL set the agenda for and hosted the NCEUG January 1994 meeting, attended by over 140 people. As a result of this presentation LLNL has been successful in obtaining tentative approval to perform an interoperability test of CALS adhering to the ANSI X.435 Standard.

Tri-state SGML Interest Group. The AFCTB sponsored Tri-state SGML Interest Group has continued to gain participation and interest in CALS strategies for digital data development. Five meetings were held between September 1993 and February 1994, with attendance increasing from 25 to over 40. This increased interest is an indicator that the commercial marketplace is rapidly embracing CALS as the preferred method of managing their digital data. A corresponding increase in AFCTB testing and other activities with interest group member employer firms is a direct result of this interest group involvement.

## 8.5 Publications

ConneXions, Vol 7, No. 9, September 1993 -- on the role of CALS in improving enterprise competitiveness, including its tie to EDI, concurrent engineering, and its future.

The PRO Exchange, December 1993, "Global Manufacturing: IGES In Action - a review of the IGES Transfer and Manufacturing Demonstration

Aviation Week and Space Technology, December 13, 1993, Industry Outlook section highlighted the IGES Transfer and Manufacturing Demonstration.

CALS Report, January 1994 -- on the LLNL/SM-ALC CALS-EDI procurement demonstration, and the AFCTB CALS-EDI Test Packet.

## **9. AFCTN CALS Bulletin Board Systems**

UNIX Internet File Server BBS. The AFCTB Internet File Server BBS has continued to show increased utilization by government and industry AFCTN participants. Data reports for the period September 93 through February 94 indicate that several international companies are beginning to download data. Firms from Australia, Canada, Denmark, Norway, and Japan have begun to request information and have shown interest in AFCTN technical expertise. An average of 1,000 downloads per month are now occurring.

PC-based AFCTN BBS. Since the last reporting period the AFCTN PC-based BBS has seen a 300% increase in usage by individuals seeking CALS information. The BBS hardware has been upgraded from a 286 to a 486 class computer system and an improved version of the GALACTICOM BBS software has been loaded. The AFCTN technical staff is presently reviewing software products to add file transfer protocol (FTP) capability for accessing and downloading data.

Technical Manual Specifications and Standards DTD Support. The AFCTN has effected an arrangement with the Technical Manual Specifications and Standards (TMSS) policy organization for managing TMSS military specification technical order document type definitions (DTDs) on both the PC-based and UNIX systems. Under this arrangement the TMSS organization controls the DTDs on each of the BBSs. This is intended to control and insure the accuracy of the DTD files that are being downloaded for use in developing actual technical orders for delivery to the government.

## **10. AFCTB Hardware/Software Enhancement**

The AFCTN has continued to modernize and enhance the hardware and software support environment in support of data testing and prototyping activities.

AFCTB Hardware and Software. The AFCTB added a Silicon Graphics, Inc., Indy computer with floptical disk and compact disk (CD) read-only memory (ROM) accessories. A Hewlett Packard Apollo series 735 also was received during this reporting period. These systems provided improved capability to support the AFCTN data compliance and IETM testing.

LLNL Hardware and Software. LLNL procured two new Macintosh platforms to help publish the test report for the CALS-EDI Small Business RFQ Test/Demonstration and to test Mac-based CALS evaluation and preparation software.

## **11. Management**

The key to the success of the AFCTN enterprise is management. Coordination, full participation, and cooperation of the organizations within the enterprise is vital. Regular video teleconferences are held between AFCTB and LLNL management. In addition to management participants, these conferences include a number of the technical staff. These interchanges have been effective in increasing the flow of information between the two organizations. In particular the teleconferences have brought the technical staff into management discussions, and fostered exchanges of technical information between these staffs. The management initiative, Customer Base Expansion described in paragraph 8.1.1, is another example of the combined technical--management cooperation being developed to enhance the effectiveness of the AFCTN.



## **Appendix A**

### **Acronym List**

ADIA	Alliance for Digital Information Applications
AFCTB	Air Force CALS Test Bed
AFCTN	Air force CALS Test Network
AFMC	Air Force Materiel Command
ALC	Air Logistic Center
ANSI	American National Standards Institute
ASC	Aeronautical Systems Center
ATOS	Automated Technical Order System
BBS	Bulletin Board System
BCL	Binary Cutter Location
CAD	Computer Aided Design
CADA	Computer Assisted Data Acceptance
CAM	Computer Aided Manufacturing
CALS	Continuous Acquisition and Life-cycle Support
CALSIMP	CALS Implementation Plan
CD	Compact Disk
CDM	Content Data Model
CE	Concurrent Engineering
CGM	Computer Graphic Metafile
CGO	CALS Government Concept of Operations
CITIS	Contractor Integrated Technical Information Service
COTS	Commercial Off The Shelf
CSCR	CALS Shared Resource Center
CSOC	Consolidated Space Operations Center
DAGC	Drawings and Graphics Committee
DEC	Digital Equipment Company
DoD	Department of Defense
DOS	Disc Operating System
DMSP	Defense Meteorological Satellite Program
DTD	Document Type Definition

EC	Electronic Commerce
EDCARS	Engineering Data Computer Assisted Retrieval System
EDI	Electronic Data Interchange
EIA	Electronics Industries Association
EMSP	
FOSI	Format Output Specification Instance
FCIM	Flexible Computer Integrated Manufacturing
FTP	File Transfer Protocol
GSS	Government Supplied Software
IATM	IGES Acceptance Test & Methodology
IDS	Integrated Data Strategy
IEC	International Electronics Conference
IETM	Interactive Electronic Technical Manual
IGES	Initial Graphics Exchange Specification
IMIS	Integrated Maintenance Information System
IPO	IGES/PDES Organization
ISG	Industrial Steering Group
ISO	International Standards Organization
JCALs	Joint Computer-aided Acquisition and Logistic Support
JEDMICS	Joint Engineering Data Management and Information Control System
JSOW	Joint Stand-Off Weapon
JSTARS	Joint Strategic and Tactical Airborne Reconnaissance System
LLNL	Lawrence Livermore National Laboratory
MIME	Multipurpose Internet Mail Extensions
MILSTAR	Military Strategic Tactical Relay
NCCIG)	Northern California CALS Interest Group
NCEUG	Northern California EDI Users Group
NTSC	Navy Training Systems Center
OO-ALC	Ogden Air Logistics Center
OSD	Office of the Secretary of Defense
PC	Personal Computer
PDES	Product Data Exchange Standard

PIL	Product Information Library
QSTR	Quick Short Test Report
RFQ	Request for Quotation
ROM	Read Only Memory
SGML	Standard Generalized Markup Language
STEP	Standard for the Exchange of Product Data
SM-ALC	Sacramento Air Logistics Center
TAG	Technology Advisory Group
TCAP	Technical Activity Proposal
TMSS	Technical Manual Specifications & Standards
TOW	
UN/EDIFACT	United Nations EDI for Administration, Commerce and Transportation
VHDL	VHSIC Hardware Description Language (VHDL)
VHSIC	Very High Speed Integrated Circuit
Xrastb	Raster Viewer

## Appendix B

### Commercial Software Used in AFCTN Testing

The following tables list the commercial software products that are currently available at the two AFCTN test facilities.

Product Vendors	Products	Applications
ArborText Inc	iges2draw ADEPT V4.2.1 g42tiff cgm2draw	IGES SGML Raster CGM
Advance Technology Center	MetaVIEW R 1.12 MetaCheck R 2.10	CGM CGM
AT&T	IDAS	Raster
AUTODESK Inc., Micro Engineering Solutions (MES)	AutoCAD R12 AutoCAD 386 R11 AutoCAD 386 R12 Checkmate V2.0c2 AutoSurf V6.0c2	IGES IGES IGES IGES, CGM IGES
Cadkey	Cadkey V4.06 Cadkey V6.0	IGES IGES
Carberry Technology	CADLeaf Plus 3.1	IGES, Raster, CGM
Corel	Ventura Publisher	Raster, CGM
Datalogics	ParserStation V3.3.6	SGML
ExotERICA Corporation	XGMLNormalizer V1.2e3.2 Validator V2.0	SGML SGML
Expert Graphics	RxHighlight V1.0	Raster
IGES Data Analysis (IDA)	CALSVIEW IGES Parser/Verifier V92 IGESView V3.0 IGESView V3.05 IGESView Windows IGESXpert V1.0	IGES, Raster, CGM IGES raster IGES IGES, Raster IGES
Incontext Systems	SGML Authoring Tool	SGML
Inset Systems Inc	HiJaak V2.1 HiJaak Pro	Raster Raster, CGM
InterCAP	X-Change V7.82	IGES, Raster, CGM
Intergraph	I/EMS 02.00.01.11 I/CIGES 02.00.01.03	IGES IGES
Internet	Interleaf 5.0	SGML
International TechneGroup Inc.	IGES/Works 1.3	IGES
Island Graphics	IslandPaint 3.0 IslandPaint 4.0	Raster, CGM CGM
Lotus Development	Freelance V2.01	CGM
McAfee & McAdam	Mark-it V2.3	SGML
Micrografx	Designer 4.0	CGM
Public Domain	sgmls	SGML
Rosetta Technologies	Preview V3.2	IGES
SoftQuad Inc	Author/Editor V2.1	SGML
Software Publishing Corporation	Harvard Graphics 3.05	CGM
USLynx	1840A Tape Handler	1840A
Wiz Worx	IGESPeek	IGES
XSoft	CALS/CALS v40.4	1840A

**Table B-1. Commercial Tools Used by the AFCTB**

Product Vendors	Products	Applications
Advanced Technology Center	ForReview for UNIX ForReview for Windows	CGM IGES, raster CGM IGES, raster
AT&T	VAN	Communications
AUTODESK, Inc.	AutoCAD 10.0	CAD
Delta Point	Graphics Tools	CGM IGES ,raster
Digit Software	MacEDI	EDI
Halcyon	DoDot	CGM
Henderson Software	MetaCheck V5	CGM
IBM	VAN	Communications
Inset Systems Inc.	Hijaak	Graphics
InterCAP	QuickEdit for UNIX X-Change for UNIX	Illustration editing CGM, raster
Internet	MIME	Communications
MICOM	IADS	SGML
Micrografx	Designer	CGM
Retix	X.400 Open Server	Communications
SoftQuad	Author/Editor	SGML
Software Publishing Corporation	Harvard Graphics for DOS Harvard Graphics for Windows	CGM CGM
St. Paul Software	EDI package	EDI
Supply Tech	STX 12	EDI
System Development Inc.	SDI Mont	CGM
WordPerfect	Intellitag	SGML

**Table B-2. Commercial Tools Used by the LLNL**